February 14, 1974

Address by

Dr. James C. Flectcher, Administrator

National Aeronautics and Space Administration

before the

National Space Club

Washington, D.C.

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I last spoke at a Space Club luncheon in November 1971.

My topic then, assigned by your program chairman, was "The NASA Space Program Today -- and Tomorrow".

At that time the "tomorrow" part of the NASA program -- the program beyond Apollo, Skylab, and Viking -- was still a bit uncertain. You were worried about it and I was, too.

We were still wrestling with various approaches to defining the Space Shuttle. And we were trying to work out something less costly and less uncertain than the so-called "Grand Tour" for exploring the Outer Planets. And we had no approved plans for the Inner Planets after Viking.

Even my concluding sentence, two years ago, was somewhat "iffy". "When we get the Space Shuttle and the Outer Planets program over the hump and into serious development", I said, "we will have the assurance of challenging and rewarding programs for tomorrow."

That situation, I am glad to report, has changed.

We got the Space Shuttle over its last big hump last week, in the President's Budget for FY 1975. We slipped a little as we approached the top, but we went over.

We now have an agreement with the Office of Management and Budget that the first manned orbital flight of the Shuttle will be launched in the second quarter of 1979, without any more slips for budgetary reasons.

We are now getting into intensive development of the Shuttle, with $800 million for Shuttle R&D in our FY '75 budget. We have to have a firm schedule from now on to manage the Shuttle effort efficiently and to coordinate the development of the advanced new payloads the Shuttle will launch and service. The OMB agrees with us on this. I am confident the Congress will also agree. Dale Myers and his team expect no delays for technological reasons.

There is a great deal of hard work still to be done, but the Shuttle, we can say, is really over the hump. And the prospects for tomorrow in the nation's space effort are much brighter for it.

We are over the hump, too, in our planetary program. Mariner 9 did it for us by mapping Mars in great detail. Pioneer 10 did it with its outstanding technical performance, its safe voyage through the Asteroid Belt, and its fascinating reports on Jupiter and its moons.

Mariner 10 has performed well, despite some difficulties, on its sweep past Venus and on toward Mercury.

In our planetary program we also have Pioneer 11 enroute to Jupiter and possibly Saturn; two Vikings scheduled to land on Mars in 1976 and, among other things, to search for life on this planet; two Mariners to be launched to Jupiter and Saturn in 1977; and -- this is a new start in our FY 1975 budget -- two Pioneer spacecraft to explore Venus in 1978.

One of the Pioneer Venus spacecraft will send four probes into the Venus atmsophere at widely separated points. The other will make special studies of the Venus atmosphere from continuous orbit.

Later this year NASA will launch the first of two Helios spacecraft developed by the Germans. They will orbit the Sun well inside the orbit of Mercury. They will not investigate the Sun itself, but what is happening in interplanetary space in this central region of the Solar System.

Helios is an excellent example of the valuable contribution other countries can make to the high priority mission of exploring throughout the Solar System.

When I say we are over the hump in our planetary program, I mean we are no longer uncertain about the future. We now have challenging programs approved for this decade, and we have a sound planning base and technology base for what we want to do in the 1980s.

I think we have "earned" this feeling of confidence about the future for two main reasons:

One. Current programs are producing results of great value to science -- and results that will have great practical value, too, like the new understanding we are getting of Earth's atmosphere and weather from our studies of the thin atmosphere of Mars and the very heavy atmosphere of Venus.

Two. We have clearly demonstrated, with Pioneer 10 and other relatively small spacecraft, that we have the technology to explore all the planets in a meaningful way, and a methodical way, at reasonable cost.

We are getting results, and we are holding down the costs. So I think we <u>should</u> and <u>will</u> get new assignments to explore throughout the Solar System during the remainder of this century.

Speaking of results, let me mention this globe of Mars I have here. It represents one of the great scientific and technical achievements of this decade.

This is a 16-inch globe, but it is based on a big one four feet in diameter. The big one was prepared from more than 1,500 actual photographs sent to Earth by Mariner. A scientific team at the Jet Propulsion Laboratory worked for more than seven months to fit these pictures together in the proper places on the globe.

Three of the large globes have been made. One is now on display at NASA Headquarters. I wanted to bring it with me today, but they said I couldn't get it on the elevator.

This smaller globe of Mars shows all the major features that are on the big one. It also shows the official names that have been given to newly discovered features of Mars by the International Astronomical Union.

I am proud to say the most prominent feature is Valles Marineris in Latin and Mariner Valley in English. This is the great rift valley that is long enough to stretch clear across the United States, and appears to be five miles deep in places.

This globe shows the polar caps at their smallest size. In other words, according to this globe it is late summer at both the North and South Pole of Mars. This was done to reveal the surface features which are obscured during the winters on Mars.

The albedo markings, the large dark areas that have been air brushed on, are what astronomers on the ground have seen, or thought they saw, over the centuries. As far as we can tell from the Mariner pictures, there is no apparent explanation for these markings. So the markings on this globe are just a blend of the old and the new -- the traditional view of Mars brought up to date with volcanic mountains, plains, craters, and what appear to have been ancient stream beds carved out by running water.

The 1973 NASA Payload Model

Our confidence in the future has been well expressed by -- and strengthened by -- a detailed planning exercise we completed last October.

The primary purpose of this exercise was to see what payloads we could develop and fly on the Space Shuttle in the 12 years from 1980 to 1991, with an annual budget at about the level we have today.

The results of the exercise are summed up in a document called The 1973 NASA Payload Model. A limited number of copies are available from NASA. It has also been reprinted in a hearing record of the Senate Committee on Aeronautical and Space Sciences entitled Space Shuttle Payloads and is for sale by the Government Printing Office.

This Payload Model is only a model, of course, and represents one version of what could be done in the 1980s. But I think it also gives a very useful indication of what we can realistically expect to be doing between now and 1991.

It is quite precise. It not only tells when we will launch a given payload, and what its purpose is. It also indicates what it will weigh, what its dimensions are, and at what heights it will orbit. This kind of precision is needed to assist in formulating the requirements for the Shuttle, Tug, and Spacelab. This precision also shows how various payloads can be combined on one Shuttle flight to reduce launch costs.

So our latest Payload Model is precise, long-range, realistic in budget terms, and available. All that makes it rather unusual as Washington documents go. At any rate, we are rather proud of it, and I think you will find it readable and useful.

It identifies a grand total of 810 payloads to be sent into space in the period from late 1973 through 1991. Of these, 60 percent will be automated, and 40 percent will be what we call sortie payloads -- that is, they will be flown in the manned Spacelab module being developed by nine European countries.

So we have these two categories of payloads -- automated and sortie. You could translate that into current terms as "unmanned" and "manned", but the terms "manned" and "unmanned" will be out of date in the Shuttle era. When the Shuttle is available, even the automated payloads will be launched to Earth orbit, serviced, and in some cases retrieved and returned to Earth by the Shuttle crews.

The grand total of 810 payloads includes non-NASA payloads for other government agencies, foreign agencies, and private industry. But Department of Defense payloads are not included.

The numbers are impressive, but much more significant is what each payload can do and what new capabilities it will create for exploring and using space. Some of the automated payloads the Shuttle takes to orbit will be very large and very sophisticated, like the Large Space Telescope which will weigh about 11 tons and carry a mirror 120 inches in diameter.

To see the shape of the future in space, let's take a look at some of these payloads, starting with the planetary missions.

Outer Planets -- Tentative Plans

Our last approved missions to the Outer Planets will be the Mariner flights to Jupiter and Saturn launched in 1977.

After that, according to tentative plans in the Payload Model, we may launch as many as 10 Mariner or Pioneer spacecraft to the Outer Planets in the 1980s, including flybys of Uranus and Neptune, probes into the atmospheres of Jupiter, Uranus, and Saturn, and orbiters around Jupiter and Saturn.

And in 1990 and 1991 we might send two very heavy payloads weighing 21,000 pounds each to orbit one of Jupiter's moons at an altitude of only 55 miles, and land an instrument package, including a TV camera, on this Jovian moon.

Most of the weight of these payloads will be accounted for by a nuclear electric propulsion stage, which will be needed to put the spacecraft in orbit around the moon of Jupiter. The descent to orbit will follow a spiral pattern.

Inner Planets -- Tentative Plans

Here are our tentative plans for the Inner Planets:

By 1983 we may send two spacecraft to orbit Venus at a low altitude of 270 miles and map the surface by radar. By 1985 we may send two spacecraft to float in the Venus atmosphere at various levels, and by 1989 we may send a Large Lander to Venus and take TV cameras and other instruments to the surface.

We may return to Mercury in 1987 with two spacecraft which would orbit this Sun-scorched planet. One spacecraft would be in a circular orbit at 270 miles altitude, and the other would be in an elliptical orbit coming within 110 miles of the surface.

Tentative Mars Missions

We have no approved Mars missions beyond the Viking landings in 1976. But according to the Payload Model we may launch another Viking to Mars in 1979, two new spacecraft to bring back surface samples from Mars in 1984, and two similar spacecraft to bring back samples from the two moons of Mars, Phobos and Deimos, in 1990 and 1991.

Tentative Plans for Automated Moon Missions

We have no approved plans to send either manned or automated spacecraft back to the Moon.

However, we are considering sending eight automated spacecraft to the Moon between 1979 and 1991.

These missions include:

- -- a Lunar Polar Orbiter in 1979;
- -- two other Lunar Orbiters in the 1980s;
- -- two Lunar Rovers in the 1980s which would travel as far as 60 miles during a year on the Moon;
- -- a so-called Lunar Halo Satellite which would assure communications with the hidden side of the Moon;
- -- and finally, in 1990 and 1991, two Lunar Rovers which could return samples to Earth from any point on the Moon. To date, no samples have been returned from the hidden side of the Moon.

Tentative Plans to Visit Comets

Comet Kohoutek has been a very valuable source of information to astronomers.

I won't have the time today to go into what we learned about Comet Kohoutek, except to say that it appears to have come from outside the Solar System, from interstellar space. And it does appear to contain water molecules and organic molecules that could be precursors of life forms.

Kohoutek is now travelling in an orbit that will return it to the inner Solar System in about 75,000 years.

However, there are some comets, called short-period comets, which come around the Sun on schedule every few years. These are the ones we plan to explore.

For example, in 1979 a spacecraft weighing about 4,500 pounds could be sent to make a slow fly-by of the Comet Encke, coming within 3,000 miles of the comet's nucleus.

Comet Encke comes back around the Sun every 3 years, so that we can make a series of close-up investigations of increasing difficulty.

After the fly-by mission, a rendezvous mission will be considered. It would permit the spacecraft to enter the inner coma of Comet Encke and travel along with it. (The coma, of course, is the nebulous mass which surrounds the nucleus of the comet.) After the spacecraft has made a close-up study of the nucleus, a landing on the nucleus might be attempted.

The missions to Comet Encke are doubly important. They will yield valuable information, and they will help us prepare for the opportunity to make a fly-by close to the best known comet of them all, Haley's Comet, in 1985.

Halley's Comet comes back around the Sun about every 75 years. Each of its appearances has been recorded since the year 240 B.C. When it returns in 1985 we will have our first opportunity to examine it with a full complement of modern instruments on the ground and in space.

It is proposed to fly the Halley spacecraft within about 5,000 miles of the comet's rucleus.

Tentative Plans to Visit Asteroids

Asteroids may be just as important to visit as planets and comets. Scientists believe asteroids can tell us a great deal about how the Solar System was formed and how life began here.

According to the Payload Model, we could send two automated spacecraft to visit large asteroids in 1986. They could send back TV pictures and other data from very close range -- from distances measured in feet rather than miles.

I assume that some day we will want to send scientists to land on asteroids. Such landings would be relatively easy to make because the gravity forces to be overcome on landing and take-off would not be great. But such landings are not in our tentative schedule for the next two decades.

Planetary exploration takes patience. It cannot all be done in one big push like the Apollo program. We have to move step by step, decade by decade, in many different directions. But even so, a great deal will be learned, and many exciting voyages made, by the time we are ready for manned missions to the planets.

Now let us look at payloads in Earth orbit in the 1980s and 1990s.

Payloads in Earth Orbit

Earth orbit, that is where most of the action will be in the Shuttle era, not out in the Solar System.

Of the 810 payloads in our planning model, only 57 are destined for the Moon or planets and 753 for Earth orbit.

That's a ratio of 14 to 1 in favor of Earth orbit.

Put another way, in the 12 years beginning with 1980, we will average three payloads per year to the Moon and planets and 57 to Earth orbit.

That's a ratio of 19 to 1 in favor of Earth orbit during the Shuttle era.

Many of our spacecraft in Earth orbit during the Shuttle era will be much more advanced and much more productive operational versions of the experimental scientific and applications spacecraft we are flying in this decade.

On the science side, there will be the Large Space Telescopes, High Energy Astronomical Observatories, Large Solar Observatories, Large Radio Astronomy Observatories, and very sophisticated focusing X-Ray Telescopes.

These large spacecraft, weighing up to 12 tons or more, will be unmanned but will be visited regularly by Space Shuttle crews and brought back to Earth for refurbishing from time to time. With these prospects for long term use, we can build excellent spacecraft for a modest investment.

With these observatories in action, we will make unprecedented gains in understanding the Universe and its energy sources in the Eighties and Nineties.

In the applications field we are considering large Earth Observatory Satellites weighing 3 1/2 tons which will be in the Sun synchronous polar orbit now used by ERTS-1. These Observatories will use advanced remote sensing techniques to monitor environmental quality, observe the weather and the oceans, survey Earth resources, and facilitate land use planning.

In other words, we think of the Earth Observatory Satellites as a modular spacecraft -- or bus -- that could carry different groups of instruments to cover a wide variety of Earth observations for many different users.

The advanced remote sensing techniques for the large Earth Observatories have been, and are being, tested out on Skylab, ERTS-1, and other current programs.

We are tentatively planning to begin launching these large operational Earth observatories in 1978. Goddard Space Flight Center has asked for proposals to study their design. Two or more companies will be selected to conduct the studies.

We also plan to have operational Earth Observatories at synchronous orbit, beginning in 1981. The forerunners of these spacecraft are the two Synchronous Meteorological Satellites we plan to orbit this year. One significant difference is that the spacecraft we will orbit this year weigh 550 pounds but those planned for the Shuttle era weigh 5,000.

Another figure that indicates the direction we are heading concerns communications and navigation satellites.

NASA has only two planned at present: the Applications Technology Satellite (ATS-F) which will be launched this year and the Cooperative Applications Satellite which we are working on with Canada and which will be launched next year.

The Payload Model, however, lists 120 communications or navigation satellites to be orbited by NASA for other agencies or private industry (not including the Department of Defense) through 1991. Forty-three of these are for commercial communications within the United States. I would guess this number will climb, but that is the present projection, and it is impressive, especially when you remember these satellites must be sent to synchronous orbit.

The trend for other agencies and other governments to use space is already clear.

Of the 25 payloads scheduled for launch by NASA this year, only eight are NASA payloads; three result from international cooperative efforts in which NASA is a partner; and 14 are being launched for others on a reimbursable basis.

Seven of the reimbursable launches involve commercial communications satellites -- three international, three domestic, and one maritime communications satellite.

I cite these figures to show that intensive use of space by others is beginning, and NASA welcomes this trend.

Of the three hundred or so sortie payloads -- those flown in the manned Spacelab module -- most will be NASA payloads.

They include substantial numbers

in Astronomy

Physics

Earth Observations

Space Processing

Earth and Ocean Physics

Communication and Navigation

Life Science

and Space Technology.

Of the non-NASA payloads, 10 are expected to be flown for private industry in the space processing field, beginning in 1985.

About 10 percent of the sortie payloads are expected to be foreign, but that's tentative, of course.

Shuttle Impact on Environment

One question naturally arises when we consider the large number of missions contemplated in our Payload Model coupled with a rapidly increasing number from the Soviet Union (which made three times as many launches as we did in 1973).

What will be the impact of all these launches on the global environment?

We have had this under careful study since the earliest consideration of the Shuttle and we expect it to have very little effect, and no harmful effect, on the environment.

The environmental impact statement that we filed two years ago discussed such things as Shuttle noise and sonic boom, and the influence of the rocket exhaust upon the atmosphere. We pointed out in that statement that the major constituents of the solid rocket booster exhaust will be water vapor, carbon dioxide, hydrogen chloride, and aluminum oxide, and we analyzed the anticipated effects on the troposphere and stratosphere, showing them to be neglibible.

Since the filing of the environmental impact statement, our continuing studies have shown that the hydrogen chloride in the booster exhaust may give rise to free chlorine in the stratosphere, which laboratory experiments indicate might catalyze the destruction of some stratospheric ozone. There are, however, no data to show that this actually happens, and it is an extremely complicated question that we will continue to study. We fully expect that this will not turn out to be a problem, but should the effects turn out to be unacceptable, there are alternative propellants that we can use in the rocket booster, and we will do so.

Benefits of Shuttle Use

I have one final point I would like to make about the 1973 NASA Payload Model.

We have used it as the basis for a current study to compare the benefits offered by the Shuttle over present day or improved expendable launch vehicles.

We have found that the benefits made possible by Shuttle use in the 12 years from 1980 through 1991 will average more than $1 billion per year.

Most of these benefits will result from the decreased cost of payloads and from their reuse, but the Shuttle also offers significant savings in transportation as well.

Questions

Now I would like to come back to the questions I usually get asked:

When will Americans return to the Moon?

When will we land men on Mars?

When will we establish a Large Space Station in Earth orbit?

Man's Return to the Moon

It is quite possible that the Russians will send men to the Moon for short stays during this decade, as we have already done in the Apollo program.

Whether we will want to send men back to the Moon on short Apollo-type missions requires further study. It is probably better to wait until we are ready to begin establishment of manned scientific bases for long term use, like our present bases in the Antarctic.

As I see it now, such bases on the Moon are not likely, even after 1991, unless they are built in international projects with the cooperation of the Soviet Union, the United States, and perhaps even Europe. Such bases would be too expensive for one country alone.

Prospects for Manned Mars Landing

I think manned exploration of Mars will be undertaken after we have had experience with large Space Stations in Earth orbit and with long stays in scientific bases on the Moon. Not that these steps are required -- rather they are logical next steps in an orderly program.

Like scientific bases on the Moon, manned expeditions to Mars will likely be organized on an international basis. Even though such an undertaking is technically feasible now and would receive enthusiastic support from a large portion of the world's population, with all the other financial problems currently facing the developed countries it is unlikely that any one of them will foot the bill by itself -- at least not in the next two decades.

Prospects for a Large Manned Space Station

Skylab has clearly shown the potential value of the Space Shuttle and the Spacelab module, which can serve as a small space station accommodating about four scientists for missions up to 30 days.

But Skylab has also convinced us that we will need Large Space Stations for long missions employing larger and more sophisticated instruments.

But NASA simply will not have the funds in this decade to develop both the Space Shuttle and a Large Space Station. Faced with that choice, we had to give priority to the Shuttle and the smaller Spacelab module.

It is very likely that the Soviet Union will develop a space station, and they may have it in orbit by the end of this decade. How it will compare in size and versatility and productivity with the manned Spacelab module the Europeans are developing for use with the Space Shuttle remains to be seen.

Conclusion

We should not be dismayed by the fact that cost factors require international cooperation on such large undertakings as scientific bases on the Moon and manned landings on Mars. We should welcome it.

I think such cooperation is an excellent way of helping to assure that we will enter the 21st century as a world at peace.

Will such long-term, large-scale international ventures in space be politically feasible one or two decades from now? I very much hope so. No one can say with certainty, of course. But I can point out that we have taken two important steps in this general direction already:

1) The scheduling of the Apollo/Soyuz Test Project for 1975 and

2) The agreement with nine European countries to develop the manned Spacelab module for use with the Space Shuttle.

And by 1991 I anticipate that it will be clear to all that if it is desired to proceed on the major space missions of the future, there is no alternative to international cooperation -- no alternative that is both feasible and appropriate in a world at peace.

It is, of course, difficult to plan now for the future beyond 1991. Our Payload Model goes about as far as one can go.

For the near future -- for the next 18 years -- we do have well planned space programs and possibilities which we can afford on a national basis, which do encourage international cooperation in space on a growing scale, and which are the logical next steps to explore and use space.

The many space achievements we have tentatively planned for the next 18 years will enrich our lives, advance our technology, and enhance our security. They will be achievements that we as a people can be very proud of.

nation would eventually be served by the survival of the Union. So the thought I would leave with the body here today, is very simply this: I too believe that America has a destiny. I do not believe that, in a sense, as some national leaders—in times past have believed it about their countries—our destiny was not to rule any other country. Our destiny is not to start war with any other country. Our destiny is not to break freedom but to defend it. Our destiny also is to recognize the right of the people in the world to be different from what we are. Even some may have different religions. Even some we must accept may not have a religious belief as we understand a religious belief. But, on the other hand, while I know this goes counter to the ideas that many of my good friends in this audience who believe—as my mother and father believed in the missionary work of our church—I think America today must understand that, in its role as a world leader, that we can only have peace in the world if we respect the rights, views of our neighbors, our friends, and the people of all the nations of the world. It is that respect for other people, despite differences in religion, that has brought us so far along the road to world understanding and world peace over these five years. Rather hard for us sometimes to have that respect. Sometimes for each other in our political process, and sometimes for other nations who have totally different political views, but I only suggest that we go back to Lincoln. Of course, I go back to my grandmother. And I would pray for this nation, at this time, and I hope all of you would too, whether orally or in silence, that we try to listen more to what God wants rather than tell God what we want. That we would try to find out what God wants America to be rather than to ask Him always to see what we believe America should be prevails. Call this humility, which they called it is Lincoln's days, call it what you like, but it is the way a great country ought to be.

America is a nation of destiny and whether freedom survives in the world and whether the weak nations of the world can be as safe as the strong, which is our goal, depends on America. I do not say this in arrogance. I do not say it without recognizing that other great powers, in a different way, may also work together with us for that great purpose, but I do know that without American strength, and I speak not just of our military strength primarily—primarily I speak of our moral strength and our spiritual strength and our faith in our national destiny—without America's strength the world would not have the chance today that it has for freedom and for peace and for justice in the years ahead. And so, my friends, may I thank you all for the prayers I know you have offered for our national leaders. May I urge you all, whatever your faiths may be, to pray in the future at times in silence. Why? Because, too often, we are a little too arrogant. We try to talk to God and tell him what we want. What all of us needs to do—what this nation needs to do—is to pray in silence and listen to God and find out what He wants for us and then we will all do the right thing. (Applause.)

Senator STENNIS. After the closing prayer, the meeting for this year will be dismissed, with the thanks of all for your attendance, for your taking part. There has been a fine response, it seems to me.

CLOSING PRAYER

Now, a member of the House of Representatives, the Honorable Andrew Young of the State of Georgia, will give our closing prayer. Please stand.

Representative YOUNG. We give Thee thanks, dear Father, for the abundance of our blessings upon us, and upon this nation. We give thee thanks for this fellowship, for the sharing of Thy blessings, for the sharing of Thy wisdom, for the opportunity to know how Thou has acted powerfully, mightifully, and mercifully, in the lives of each of us. And yet, dear Father, it would be inappropriate if we closed without confessing our sins, for we know, too, that we have erred and strayed from Thy ways like lost sheep. We have often followed too much the devices and desires of our own hearts, and offended against Thy holy laws, but we are thankful than Thou art merciful, and thus continue to be with us, not because we merit, but because Thou does love us, even when we are weak, even when we go astray. We pray that in Thine abundant blessings, Thou might help us to know that, to us to whom much has been given, of us much will be required. Require of us personally a kind of dedication and service to this nation that seeks not to transcend Thy cause of peace in the world, but seeks to fulfill that cause of peace. Help us to use the power and might with which Thou has blessed us, not in any arrogant, self-glorification, but in humble and obedient service to feed the hungry, to educate the children, to heal the sick, and to prepare amongst the highways and byways, a straight and glorious path through which all of Thy powers and mercies might be revealed to all men. We pray, dear Father, that as we leave this place that Thou will bless us and keep us. That Thou would make Thy face to shine upon us and be gracious unto us. We pray that thou will lift up the light of Thy countenance upon us and give us great faith. Give us courage amidst the days' crisis and give us a sense of understanding of Thy will, through which we might find true and lasting peace. Through Jesus Christ, our Lord, we pray. Amen.

DR. FLETCHER'S REMARKS AT SPACE CLUB LUNCHEON

Mr. MOSS. Mr. President, last week Administrator Fletcher of the National Aeronautics and Space Administration addressed a luncheon meeting of the National Space Club here in Washington. His remarks concisely sunmmarize the present status and future opportunities of the Nation's peaceful pursuits of exploration and use of outer space. I ask unanimous consent that Dr. Fletcher's remarks be printed in the RECORD.

There being no objection, the remarks were ordered to be printed in the RECORD, as follows:

DR. FLETCHER'S REMARKS, FEBRUARY 14, 1974

I last spoke at a Space luncheon in November 1971.

My topic then, assigned by your program chairman, was "The NASA Space Program Today—and Tomorrow".

At that time the "tomorrow" part of the NASA program—the program beyond Apollo, Skylab, and Viking—was still a bit uncertain. You were worried about it and I was, too.

We were still wrestling with various approaches to defining the Space Shuttle. And we were trying to work out something less costly and less uncertain than the so-called "Grand Tour" for exploring the Outer Planets. And we had no approved plans for the Inner Planets after Viking.

Even my concluding sentence, two years ago, was somewhat "iffy". When we get the Space Shuttle and the Outer Planets program over the hump and into serious development", I said, "we will have the assurance of challenging and rewarding programs for tomorrow."

That situation, I am glad to report, has changed.

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There is a great deal of hard work still to be done, but the Shuttle, we can say, is really over the hump. And the prospects for tomorrow in the nation's space effort are much brighter for it.

We are over the hump, too, in our planetary program. Mariner 9 did it for us by mapping Mars in great detail. Pioneer 10 did it with its outstanding technical performance, its safe voyage through the Asteroid Belt, and its fascinating reports on Jupiter and its moons.

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When I say we are over the hump in our planetary program, I mean we are no longer uncertain about the future. We now have challenging programs approved for this decade, and we have a sound planning base and technology base for what we want to do in the 1980s.

I think we have "earned" this feeling of confidence about the future for two main reasons:

One. Current programs are producing results of great value to science—and results that will have great practical value, too, like the new understanding we are getting of Earth's atmosphere and weather from our studies of the thin atmosphere of Mars and the very heavy atmosphere of Venus.

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We are getting results, and we are holding down the costs. So I think we *should* and *will* get new assignments to explore throughout the Solar System during the remainder of this century.

Speaking of results, let me mention this globe of Mars I have here. It represents one of the great scientific and technical achievements of this decade.

This is a 16-inch globe, but it is based on a big one four feet in diameter. The big one was prepared from more than 1,500 actual photographs sent to Earth by Mariner. A scientific team at the Jet Propulsion Laboratory worked for more than seven months to fit these pictures together in the proper places on the globe.

Three of the large globes have been made. One is now on display at NASA Headquarters. I wanted to bring it with me today, but they said I couldn't get it on the elevator.

This smaller globe of Mars shows all the major features that are on the big one. It also shows the official names that have been given to newly discovered features of Mars by the International Astronomical Union.

I am proud to say the most prominent feature is Valles Marineris in Latin and Mariner Valley in English. This is the great rift valley that is long enough to stretch clear across the United States, and appears to be five miles deep in places.

This globe shows the polar caps at their smallest size. In other words, according to this globe it is late summer at both the North and South Pole of Mars. This was done to reveal the surface features which are obscured during the winters on Mars.

The albedo markings, the large dark areas that have been air brushed on, are what astronomers on the ground have seen, or thought they saw, over the centuries. As far as we can tell from the Mariner pictures, there is no apparent explanation for these markings. So the markings on this globe are just a blend of the old and the new—the traditional view of Mars brought up to date with volcanic mountains, plains, craters, and what appear to have been ancient stream beds carved out by running water.

THE 1973 NASA PAYLOAD MODEL

Our confidence in the future has been well expressed by—and strengthened by—a detailed planning exercise we completed last October.

The primary purpose of this exercise was to see what payloads we could develop and fly on the Space Shuttle in the 12 years from 1980 to 1991, with an annual budget at about the level we have today.

The results of the exercise are summed up in a document called *The 1973 NASA Payload Model*. A limited number of copies are available from NASA. It has also been reprinted in a hearing record of the Senate Committee on Aeronautical and Space Sciences entitled *Space Shuttle Payloads* and is for sale by the Government Printing Office.

This Payload Model is *only* a model, of course, and represents one version of what *could* be done in the 1980s. But I think it also gives a very useful indication of what we can realistically expect to be doing between now and 1991.

It is quite precise. It not only tells when we will launch a given payload, and what its purpose is. It also indicates what it will weigh, what its dimensions are, and at what heights it will orbit. This kind of precision is needed to assist in formulating the requirements for the Shuttle, Tug, and Spacelab. This precision also shows how various payloads can be combined on one Shuttle flight to reduce launch costs.

So our latest *Payload Model* is precise, long-range, realistic in budget terms, *and available*. All that makes it rather unusual as Washington documents go. At any rate, we are rather proud of it, and I think you will find it readable and useful.

It identifies a grand total of 810 payloads to be sent into space in the period from late 1973 through 1991. Of these, 60 percent will be automated, and 40 percent will be what we call sortie payloads—that is, they will be flown in the manned Spacelab module being developed by nine European countries.

So we have these two categories of payloads—automated and sortie. You could translate that into current terms as "unmanned" and "manned", but the terms "manned" and "unmanned" will be out of date in the Shuttle era. When the Shuttle is available, even the automated payloads will be launched to Earth orbit, serviced, and in some cases retrieved and returned to Earth by the Shuttle crews.

The grand total of 810 payloads includes non-NASA payloads for other government agencies, foreign agencies, and private industry. But Department of Defense payloads are not included.

The numbers are impressive, but much more significant is what each payload can do and what new capabilities it will create for exploring and using space. Some of the automated payloads the Shuttle takes to orbit will be very large and very sophisticated, like the Large Space Telescope which will weigh about 11 tons and carry a mirror 120 inches in diameter.

To see the shape of the future in space, let's take a look at some of these payloads, starting with the planetary missions.

OUTER PLANETS—TENTATIVE PLANS

Our last approved missions to the Outer Planets will be the Mariner flights to Jupiter and Saturn launched in 1977.

After that, according to tentative plans in the *Payload Model*, we may launch as many as 10 Mariner or Pioneer spacecraft to the Outer Planets in the 1980s, including flybys of Uranus and Neptune, probes into the atmospheres of Jupiter, Uranus, and Saturn, and orbiters around Jupiter and Saturn.

And in 1990 and 1991 we might send two very heavy payloads weighing 21,000 pounds each to orbit one of Jupiter's moons at an altitude of only 55 miles, and land an instrument package, including a TV camera, on this Jovian moon.

Most of the weight of these payloads will be accounted for by a nuclear electric propulsion stage, which will be needed to put the spacecraft in orbit around the moon of Jupiter. The descent to orbit will follow a spiral pattern.

INNER PLANETS—TENTATIVE PLANS

Here are our tentative plans for the Inner Planets:

By 1983 we may send two spacecraft to orbit Venus at a low altitude of 270 miles and map the surface by radar. By 1985 we may send two spacecraft to float in the Venus atmosphere at various levels, and by 1989 we may send a Large Lander to Venus and take TV cameras and other instruments to the surface.

We may return to Mercury in 1987 with two spacecraft which would orbit this Sun-scorched planet. One spacecraft would be in a circular orbit at 270 miles altitude, and the other would be in an elliptical orbit coming within 110 miles of the surface.

TENTATIVE MARS MISSIONS

We have no approved Mars missions beyond the Viking landings in 1976. But according to the *Payload Model* we may launch another Viking to Mars in 1979, two new spacecraft to bring back surface samples from Mars in 1984, and two similar spacecraft to bring back samples from the two moons of Mars, Phobos and Deimos, in 1990 and 1991.

TENTATIVE PLANS FOR AUTOMATED MOON MISSIONS

We have no approved plans to send either manned or automated spacecraft back to the Moon.

However, we are considering sending eight automated spacecraft to the Moon between 1979 and 1991.

These missions include: a Lunar Polar Orbiter in 1979; two other Lunar Orbiters in the 1980's; two Lunar Rovers in the 1980s which would travel as far as 60 miles during a year on the Moon; a so-called Lunar Halo Satellite which would assure communications with the hidden side of the Moon; and finally, in 1990 and 1991, two Lunar Rovers which could return samples to Earth from any point on the Moon. To date, no samples have been returned from the hidden side of the Moon.

TENTATIVE PLANS TO VISIT COMETS

Comet Kohoutek has been a very valuable source of information to astronomers.

I won't have the time today to go into what we learned about Comet Kahoutek, except to say that it appears to have come from outside the Solar System, from interstellar space. And it does appear to contain water molecules and organic molecules that could be precursors of life forms.

Kohoutek is now travelling in an orbit that will return it to the inner Solar System in about 75,000 years.

However, there are some comets, called short-period comets, which come around the Sun on schedule every few years. These are the ones we plan to explore.

For example, in 1979 a spacecraft weighing about 4,500 pounds could be sent to make a slow fly-by of the Comet Encke, coming within 3,000 miles of the comet's nucleus.

Comet Encke comes back around the Sun every 3 years, so that we can make a series of close-up investigations of increasing difficulty.

After the fly-by mission, a rendezvous mission will be considered. It would permit the spacecraft to enter the inner coma of Comet Encke and travel along with it. (The coma, of course, is the nebulous mass which surrounds the nucleus of the comet.) After the spacecraft has made a close-up study of the nucleus, a landing on the nucleus might be attempted.

The missions to Comet Encke are doubly important. They will yield valuable information, and they will help us prepare for the opportunity to make a fly-by close to the best known comet of them all, Haley's Comet, in 1985.

Haley's Comet comes back around the Sun about every 75 years. Each of its appearances has been recorded since the year 240 B.C. When it returns in 1985 we will have our first opportunity to examine it with a full complement of modern instruments on the ground and in space.

It is proposed to fly the Haley spacecraft within about 5,000 miles of the comet's nucleus.

TENTATIVE PLANS TO VISIT ASTEROIDS

Asteroids may be just as important to visit as planets and comets. Scientists believe asteroids can tell us a great deal about how the Solar System was formed and how life began here.

According to the *Payload Model*, we could send two automated spacecraft to visit large asteroids in 1986. They could send back TV pictures and other data from very close range—from distances measured in feet rather than miles.

I assume that some day we will want to send scientists to land on asteroids. Such landings would be relatively easy to make because the gravity forces to be overcome on landing and take-off would not be great. But such landings are not in our *tentative schedule* for the next two decades.

Planetary exploration takes patience. It cannot all be done in one big push like the Apollo program. We have to move step by step, decade by decade, in many different directions. But even so, a great deal will be learned, and many exciting voyages made, by the time we are ready for manned missions to the planets.

Now let us look at payloads in Earth orbit in the 1980s and 1990s.

PAYLOADS IN EARTH ORBIT

Earth orbit, that is where most of the action will be in the Shuttle era, not out in the Solar System.

Of the 810 payloads in our planning model, only 57 are destined for the Moon or planets and 753 for Earth orbit.

That's a ratio of 14 to 1 in favor of Earth orbit.

Put another way, in the 12 years beginning with 1980, we will average three payloads per year to the Moon and planets and 57 to Earth orbit.

That's a ratio of 19 to 1 in favor of Earth orbit during the Shuttle era.

Many of our spacecraft in Earth orbit during the Shuttle era will be much more advanced and much more productive operational versions of the experimental scientific and applications spacecraft we are flying in this decade.

On the science side, there will be the Large Space Telescopes, High Energy Astronomical Observatories, Large Solar Observatories, Large Radio Astronomy Observatories, and very sophisticated focusing X-Ray Telescopes.

These large spacecraft, weighing up to 12 tons or more, will be unmanned but will be visited reguraly by Space Shuttle crews and brought back to Earth for refurbishing from time to time. With these prospects for long term use, we can build excellent spacecraft for a modest investment.

With these observatories in action, we will make unprecedented gains in understanding the Universe and its energy sources in the Eighties and Nineties.

In the applications field we are considering large Earth Observatory Satellites weighing 3½ tons which will be in the Sun synchronous polar orbit now used by ERTS-1. These Observatories will use advanced remote sensing techniques to monitor environmental quality, observe the weather and the oceans, survey Earth resources, and facilitate land use planning.

In other words, we think of the Earth Observatory Satellites as a modular spacecraft—or bus—that could carry different groups of instruments to cover a wide variety of Earth observations for many different users.

The advanced remote sensing techniques for the large Earth Observatories have been, and are being, tested out in Skylab, ERTS-1, and other current programs.

We are tentatively planning to begin launching these large operational Earth Observatories in 1978. Goddard Space Flight Center has asked for proposals to study their design. Two or more companies will be selected to conduct the studies.

We also plan to have operational Earth Observatories at synchronous orbit, beginning in 1981. The forerunners of these spacecraft are the two Synchronous Meteorological Satellites we plan to orbit this year. One significant difference is that the spacecraft we will orbit this year weigh 550 pounds but those planned for the Shuttle era weigh 5,000.

Another figure that indicates the direction we are heading concerns communications and navigation satellites.

NASA has only two planned at present: the Applications Technology Satellite (ATS-F) which will be launched this year and the Cooperative Applications Satellite which we are working on with Canada and which will be launched next year.

The *Payload Model*, however, lists 120 communications or navigation satellites to be orbited by NASA for other agencies or private industry (not including the Department of Defense) through 1991. Forty-three of these are for commercial communications within the United States. I would guess this number will climb, but that is the present projection, and it is impressive, especially when you remember these satellites must be sent to synchronous orbit.

The trend for other agencies and other governments to use space is already clear.

Of the 25 payloads scheduled for launch by NASA this year, only eight are NASA payloads; three result from international cooperative efforts in which NASA is a partner; and 14 are being launched for others on a reimbursable basis.

Seven of the reimbursable launches involve commercial communications satellites—three international, three domestic, and one maritime communications satellite.

I cite these figures to show that intensive use of space by others is beginning, and NASA welcomes this trend.

Of the three hundred or so sortie payloads—those flown in the manned Spacelab module—most will be NASA payloads.

They include substantial numbers in: Astronomy; Physics; Earth Observations; Space Processing; Earth and Ocean Physics; Communication and Navigation; Life Science; and Space Technology.

Of the non-NASA payloads, 10 are expected to be flown for private industry in the space processing field, beginning in 1985.

About 10 percent of the sortie payloads are expected to be foreign, but that's tentative, of course.

SHUTTLE IMPACT ON ENVIRONMENT

One question naturally arises when we consider the large number of missions contemplated in our *Payload Model* coupled with a rapidly increasing number from the Soviet Union (which made three times as many launches as we did in 1973).

What will be the impact of all these launches on the global environment?

We have had this under careful study since the earliest consideration of the Shuttle and we will design and fly a Shuttle which has *no harmful* effects on the environment.

The environmental impact statement filed two years ago discussed Shuttle noise and sonic boom, and also attempted to define the possible atmospheric influence of various exhaust gases. The atmospheric effects of added gases are complex and difficult to predict in advance—witness the problems with the automobile.

NASA has encouraged and funded the best people in atmospheric science to carry on a continuing study of Shuttle related atmospheric science to carry on a continuing study of Shuttle related atmospheric effects. This coordination with the knowledgeable scientific community is a key element in the Shuttle developmental program.

The effects of hydrogen chloride emissions from the Shuttle booster are currently under intensive study, with a particular focus on the posible effects of chlorine on atmospheric ozone. The plans involve a careful coordination of theoretical laboratory and field work. We do not think this will be a problem, but should the effects of using the propellants planned for the present Shuttle design turn out to be unacceptable, NASA has the option and indeed the commitment to proceed with alternative propellants.

BENEFITS OF SHUTTLE USE

I have one final point I would like to make about the *1973 NASA Payload Model*.

We have used it as the basis for a current study to compare the benefits offered by the Shuttle over present day or improved expendable launch vehicles.

We have found that the benefits made possible by Shuttle use in the 12 years from 1980 through 1991 will average more than $1 billion per year.

Most of these benefits will result from the decreased cost of payloads and from their reuse, but the Shuttle also offers significant savings in transportation as well.

QUESTIONS

Now I would like to come back to the questions I usually get asked: When will Americans return to the Moon?

When will we land men on Mars?

When will we establish a Large Space Station in Earth orbit?

MAN'S RETURN TO THE MOON

It is quite possible that the Russians will send men to the Moon for short stays during this decade, as we have already done in the Apollo program.

Whether we will want to send men back to the Moon on short Apollo-type missions requires further study. It is probably better to wait until we are ready to begin establishment of manned scientific bases for long term use, like our present bases in the Antarctic.

As I see it now, such bases on the Moon are not likely, even after 1991, unless they are built in international projects with the cooperation of the Soviet Union, the United States, and perhaps even Europe. Such bases would be too expensive for one country alone

PROSPECTS FOR MANNED MARS LANDING

I think manned exploration of Mars will be undertaken after we have had experience with large Space Stations in Earth orbit and with long stays in scientific bases on the Moon. Not that these steps are required—rather they are logical next steps in an orderly program.

Like scientific bases on the Moon, manned expeditions to Mars will likely be organized on an international basis. Even though such an undertaking is technically feasible now and would receive enthusiastic support from a large portion of the world's population, with all the other financial problems currently facing the developed countries it is unlikely that any one of them will foot the bill by itself—at least not in the next two decades.

PROSPECTS FOR A LARGE MANNED SPACE STATION

Skylab has clearly shown the potential value of the Space Shuttle and the Spacelab module, which can serve as a small space station accommodating about four scientists for missions up to 30 days.

But Skylab has also convinced us that we we will need Large Space Stations for long missions employing larger and more sophisticated instruments.

But NASA simply will not have the funds in this decade to develop both the Space Shuttle and a Large Space Station. Faced with that choice, we had to give priority to the Shuttle and the smaller Spacelab module.

It is very likely that the Soviet will develop a space station, and they may have it in orbit by the end of this decade. How it will compare in size and versatility and productivity with the manned Spacelab module the Europeans are developing for use with the Space Shuttle remains to be seen.

Conclusion

We should not be dismayed by the fact that cost factors require international cooperation on such large undertakings as scientific bases on the Moon and manned landings on Mars. We should welcome it.

I think such cooperation is an excellent way of helping to assure that we will enter the 21st century as a world at peace.

Will such long-term, large-scale international ventures in space be politically feasible one or two decades from now? I very much hope so. No one can say with certainty, of course. But I can point out that we have taken two important steps in this general direction already:

(1) The scheduling of the Apollo/Soyuz Test Project for 1975 and

(2) The agreement with nine European countries to develop the manned Spacelab module for use with the Space Shuttle.

And by 1991 I anticipate that it will be clear to all that if it is desired to proceed on the major space missions of the future, there is no alternative to international cooperation—no alternative that is both feasible and appropriate in a world at peace.

It is, of course, difficult to plan now for the future beyond 1991. Our *Payload Model* goes about as far as one can go.

For the near future—for the next 18 years—we do have well planned space programs and possibilities which we can afford on a national basis, which do encourage international cooperation in space on a growing scale, and which are the logical next steps to explore and use space.

The many space achievements we have tentatively planned for the next 18 years will enrich our lives, advance our technology, and enhance our security. They will be achievements that we as a people can be very proud of.

MISSING IN ACTION

Mr. McCLURE. Mr. President, the fate of all the 1,300 Americans listed as "missing in action" in Vietnam remains today unresolved. Failure of the North Vietnamese and Viet Cong to comply with specific provisions in the Paris cease-fire agreements for the release of information on the MIA's is of utmost concern to the people of the United States. Congress must not allow the return of our POW's to be half realized and leave those remaining families a "lone voice crying in the wilderness." But rather, we must recognize that voice as an inspiration to this Congress and act in a decisive manner to expedite a prompt and safe accounting for those yet "missing in action."

At the recent mid-winter conference of the American Legion Auxiliary in Boise, Idaho, the question of American MIA's was thoughtfully considered. In support of those families personally involved, the auxiliary joined them in expressing urgent demand for immediate release of the MIA's and pass a resolution to this effect. I am indebted to Mrs. Patty Halstrom of Weiser, Idaho for bringing this to my attention.

I ask unanimous consent that this important resolution be printed in the RECORD.

There being no objection, the resolution was ordered to be printed in the RECORD, as follows:

RESOLUTION—U.S. SERVICEMEN LISTED AS MISSING IN ACTION

Whereas: One year ago, January 27, 1973, there was an agreement by the governments of the United States and North Vietnam to cease firing at the armed forces of each other, and

Whereas: It was agreed that a full accounting would be made of those listed as dead and to return those being held prisoner and that every effort would be made to account for those listed as missing in action, and,

Whereas: Actual events since these agreements were signed has been that the United States government agencies assigned to make an accounting have come to a point of now only giving token lip service to their responsibilities, and,

Whereas: The government of North Vietnam has been reluctant to give assistance toward making an accurate accounting, and in some instances displayed contempt and hostile action, including murder, in retarding the sincere efforts of our inspection teams, which has resulted in a lack of spirit of the inspection teams to carry out their responsibilities, and,

Whereas: Certain steps and measures have been taken to discontinue search efforts and to reclassify status of those listed as missing to a classification of dead, which is considered to be presumptive under the conditions previously mentioned along with the fact that certain U.S. servicemen are known to have survived crash or battle and in fact appeared in interviews while being held captive, now therefore be it

Resolved, by the American Legion Auxiliary, Department of Idaho, in assembly at their annual Mid-Winter Conference in Boise, Idaho January 26, 1974, that,

We urge the United States Senate Foreign Relations Committee to continue to conduct hearings on the fate of those men who are listed as "missing in action", and be it further

Resolved: That Congress use every means at its disposal to make sure that all men listed as "missing in action" be fully accounted for.

FOREIGN MINISTERS CONFERENCE IN MEXICO CITY

Mr. BENTSEN. Mr. President, I commend Secretary Kissinger for the frank and open spirit in which he met with his Latin American colleagues at the Foreign Ministers Conference last week in Mexico City. But I am disappointed that no concrete solutions to the pressing problems of our hemisphere came out of that meeting. I—and many others—were hopeful that some concrete results would be achieved on such important matters as the role of multinational corporations, private foreign investment, civil rights and human liberties, restructuring of the hemisphere's political and economic relations, and the OAS embargo of Cuba. A frank and open dialog, and the promise of more to come, is important but must lead to real accomplishments, and as yet we have seen too little of this. The Secretary made a good start by reaching agreements with Mexico on the salinity of the Colorado River and with Peru on the expropriation of American firms; but it has taken years to accomplish these goals. Much more remains to be done, and I am fearful that it will take years more to resolve the other outstanding issues. It appears once again that decisions on the really difficult problems have been postponed. I repeat, substantive dialog on foreign policy issues is important. But headlines heralding "a new relationship" or "a new dialog" must not mask the lack of any real progress toward resolving the problems.

THE ENERGY CRISIS

Mr. FANNIN. Mr. President, it is time for this Congress to stop trying to fool ourselves and the American people concerning the solution to the energy crisis. The only realistic solution is to allow the prices for various fuels to seek their free market levels which will produce maximum supply.

The so-called windfall profits tax scheme and the irrational oil price rollback plan were subterfuges that would plainly be counterproductive to solution of our problem. We need to increase supply, not mutilate the production and supply system.

The Journal of Commerce ran a very good editorial on Monday. It was captioned, "An Expensive Illusion." The oil price rollback scheme most certainly is "an expensive illusion."

Mr. President, I ask unanimous consent to have this editorial printed in the RECORD for the benefit of my colleagues who are deeply concerned about this issue.

There being no objection, the editorial was ordered to be printed in the RECORD, as follows:

AN EXPENSIVE ILLUSION

On Occasions too numerous to count of late we have heard such proposals as a rollback of crude oil prices supported with the argument that each would "have consumers" unspecified sums of money usually running well into the hundreds of millions, if not to even more. This is a thought that seems to have gained great popularity on evening TV newscasts. It has gained enough, at least, to merit some comment.

The current proposals of this sort are similar to those put forward last year, mostly in reference to food prices. If meat prices were to be frozen, or if other food prices were frozen or even rolled back, it was said, the producers and distributors would continue to perform their functions, though at reduced profit levels, the assumption being that they would do so because they had no option to do otherwise. The consumer, in the meantime, would be given every bit of protection the government was bound to provide.

The arguments advanced then were just as misleading as those presented so airily today in another context. They are misleading because they assume that the available supply is constant and certain to remain so.

If that had been true with meat last year, then it could be assumed to be equally true of crude oil and petroleum products this year. If all the meat that the American people wanted to buy was flowing freely through the markets then, and if all the oil the nation can usefully absorb were flowing equally freely now, then it wouldn't make much difference to the public as a whole whether the producers and middlemen were forced to make do with reduced profits, even sharply reduced profits or perhaps no profits at all.

But that was not the case then nor is it the case now. The first effect of the meat price freeze was too drive a lot of the quality cuts off the shelves of retailers. The second, which seemed to come as a shock to a good part of the nation, was to force wide cutbacks in cattle production. These cutbacks, made in various ways and for various reasons in different areas, threatened shortages that could not by any manner of means be considered as temporary.

Nor was there anything secretive about them. Anybody who wanted to study the figures could find their meaning plainly stated: no matter how low the price, there was no longer going to be as much meat as there had been.

Those who had taken the trouble to do their homework (and quite a number of congressmen apparently hadn't) could see that with feedgrain prices rising rapidly while a lid was being clamped tightly on retail prices, cattle raisers would only go on raising cattle if the packers and middlemen accepted the entire brunt of the squeeze. But this was not to be.

But even while these warnings were being sounded, by this newspaper among others, the nation's more optimistic folk continued to whistle past the graveyard and to insist, during pauses for breath, that nothing could be inherently wrong about using the powers of a benevolent government to protect the consumers against excessively high food prices.

Well, as it happened the price levels were protected for a while but the consumers were in for a surprise. Much of the food they wanted most wasn't there anymore. The price lists were, but the better cuts were not. There were the usual rumors of hoarding but not much disposition to face the truth. A good deal of meat that otherwise would have been on the shelves wasn't there because it was no longer being produced and distributed.

aerospace perspectives

THE LIMITLESS HORIZONS OF SPACE

Dr. James C. Fletcher, Administrator of the National Aeronautics and Space Administration, recently presented a wide-ranging view of expected directions, scope and progress in national and international space programs from now through the next 18 years — the practical limit for realistic planning. This issue of Aerospace Perspectives *presents the major portion of his address before the National Space Club in Washington, D. C., in mid-February.* — Editor

As recently as two years or so ago we were still wrestling with various approaches to defining the Space Shuttle. And we were trying to work out something less costly and less uncertain than the so-called "Grand Tour" for exploring the Outer Planets. And we had no approved plans for the Inner Planets after Viking.

Even two years ago, I was somewhat "iffy" in saying "When we get the Space Shuttle and the Outer Planets programs over the hump and into serious development we will have the assurance of challenging and rewarding programs for tomorrow."

That situation, I am glad to report, has changed.

We got the Space Shuttle over its last big hump within the President's Budget for Fiscal Year 1975. We slipped a little as we approached the top, but we went over.

We now have an agreement with the Office of Management and Budget that the first manned orbital flight of the Shuttle will be launched in the second quarter of 1979, without any more slips for budgetary reasons.

We are now getting into intensive development of the Shuttle, with $800 million for Shuttle R&D in our FY 1975 budget. We have to have a firm schedule from now on to manage the Shuttle effort efficiently and to coordinate the development of the advanced new payloads the Shuttle will launch and service.

There is a great deal of hard work still to be done, but the Shuttle, we can say, is really over the hump. And the prospects for tomorrow in the nation's space effort are much brighter for it.

We are over the hump, too, in our planetary program. Mariner 9 did it for us by mapping Mars in great detail. Pioneer 10 did it with its outstanding technical performance, its safe voyage through the Asteroid Belt, and its fascinating reports on Jupiter and its moons.

Mariner 10 has performed well, despite some difficulties, on its sweep past Venus and on toward Mercury.

In our planetary program we also have:

- Pioneer 11 enroute to Jupiter and possibly Saturn.
- Two Vikings scheduled to land on Mars in 1976 and, among other things, to search for life on this planet.
- Two Mariners to be launched to Jupiter and Saturn in 1977.
- And — this is a new start in our FY 1975 budget — two Pioneer spacecraft to explore Venus in 1978. One of the Pioneer Venus spacecraft will send four probes into the Venus atmosphere at widely separated points. The other will make special studies of the Venus atmosphere from continuous orbit.

Later this year NASA will launch the first of two Helios spacecraft developed by the Germans. They will orbit the Sun well inside the orbit of Mercury. They will not investigate the Sun itself, but what is happening in interplanetary space in this central region of the Solar System.

Helios is an excellent example of the valuable contribution other countries can make to the high priority mission of exploring throughout the Solar System.

When I say we are over the hump in our planetary program, I mean we are no longer uncertain about the future. We now have challenging programs approved for this decade, and we have a sound planning base and technology base for what we want to do in the 1980s.

I think we have "earned" this feeling of confidence about the future for two main reasons.

One: Current programs are producing results of great value to science — and results that will have great practical value, too, like the new understanding we are getting of Earth's atmosphere and weather from our studies of the thin atmosphere of Mars and the very heavy atmosphere of Venus.

Two: We have clearly demonstrated, with Pioneer 10 and other relatively small spacecraft, that we have the technology to explore all the planets in a meaningful way, and a methodical way, at reasonable cost.

We are getting results, and we are holding down the costs. So I think we *should* and *will* get new assignments to explore throughout the Solar System during the remainder of this century.

The 1973 NASA Payload Model

Our confidence in the future has been well expressed by — and strengthened by — a detailed planning exercise we completed last October.

The primary purpose of this exercise was to see what

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payloads we could develop and fly on the Space Shuttle in the 12 years from 1980 to 1991, with an annual budget at about the level we have today.

The results of the exercise are summed up in a document called the "1973 NASA Payload Model" which represents one version of what *could* be done in the 1980s. But I think it also gives a very useful indication of what we can realistically expect to be doing between now and 1991.

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It identifies a grand total of 810 payloads to be sent into space in the period from late 1973 through 1991. Of these, 60 percent will be automated, and 40 percent will be what we call sortie payloads — that is, they will be flown in the manned Spacelab module being developed by nine European countries.

So we have these two categories of payloads — automated and sortie. You could translate that into current terms as "unmanned" and "manned," but the terms "manned" and "unmanned" will be out of date in the Shuttle era. When the Shuttle is available, even the automated payloads will be launched to Earth orbit, serviced, and in some cases retrieved and returned to Earth by the Shuttle crews.

The grand total of 810 payloads includes non-NASA payloads for other government agencies, foreign agencies, and private industry. But Department of Defense payloads are not included.

The numbers are impressive, but much more significant is what each payload can do and what new capabilities it will create for exploring and using space. Some of the automated payloads the Shuttle takes to orbit will be very large and very sophisticated, like the Large Space Telescope which will weigh about 11 tons and carry a mirror 120 inches in diameter.

To see the shape of the future in space, let's take a look at some of these payloads, starting with the planetary missions.

Outer Planets — Tentative Plans

Our last approved missions to the Outer Planets will be the Mariner flights to Jupiter and Saturn launched in 1977.

After that, according to tentative plans in the "Payload Model," we may launch as many as 10 Mariner or Pioneer spacecraft to the Outer Planets in the 1980s, including flybys of Uranus and Neptune, probes into the atmosphere of Jupiter, Uranus, and Saturn, and orbiters around Jupiter and Saturn.

And in 1990 and 1991 we might send two very heavy payloads weighing 21,000 pounds each to orbit one of Jupiter's moons at an altitude of only 55 miles, and land an instrument package, including a TV camera, on this Jovian moon.

Most of the weight of these payloads will be accounted for by a nuclear electric propulsion stage, which will be needed to put the spacecraft in orbit around the moon of Jupiter. The descent to orbit will follow a spiral pattern.

Inner Planets — Tentative Plans

Here are our tentative plans for the Inner Planets:

By 1983 we may send two spacecraft to orbit Venus at a low altitude of 270 miles and map the surface by radar. By 1985 we may send two spacecraft to float in the Venus atmosphere at various levels, and by 1989 we may send a Large Lander to Venus and take TV cameras and other instruments to the surface.

We may return to Mercury in 1987 with two spacecraft which would orbit this Sun-scorched planet. One spacecraft would be in a circular orbit at 270 miles altitude, and the other would be in an elliptical orbit coming within 110 miles of the surface.

Tentative Mars Missions

We have no approved Mars missions beyond the Viking landings in 1976. But according to the "Payload Model" we may launch another Viking to Mars in 1979, two new spacecraft to bring back surface samples from Mars in 1984, and two similar spacecraft to bring back samples from the two moons of Mars, Phobos and Deimos, in 1990 and 1991.

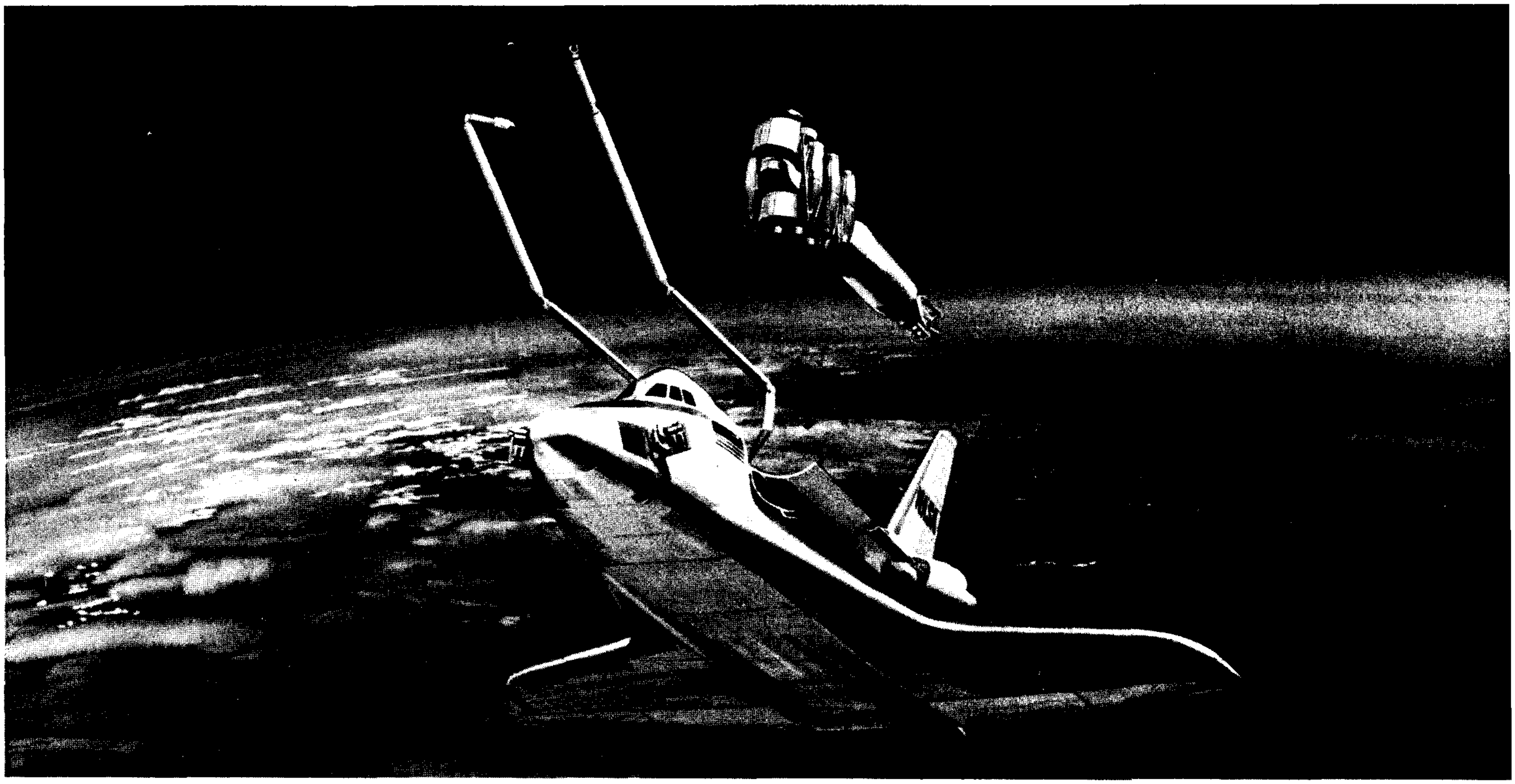
Tentative Plans for Automated Moon Missions

We have no *approved* plans to send either manned or automated spacecraft back to the Moon.

However, we are *considering* sending eight automated spacecraft to the Moon between 1979 and 1991.

These missions include:

- A Lunar Polar Orbiter in 1979;
- Two other Lunar Orbiters in the 1980s;
- Two Lunar Rovers in the 1980s which would travel as far as 60 miles during a year on the Moon;
- A so-called Lunar Halo Satellite which would assure communications with the hidden side of the Moon;
- And finally, in 1990 and 1991, two Lunar Rovers which could return samples to Earth from any point on the



Shuttle orbiter, with manipulator arms extended, prepares to recover orbiting satellite. Shuttle system can retrieve payloads in orbit for repair or maintenance in space or for return to Earth.

Moon. To date, no samples have been returned from the hidden side of the Moon.

Tentative Plans to Visit Comets

Comet Kohoutek has been a very valuable source of information to astronomers.

It appears to have come from outside the Solar System, from interstellar space. And it does appear to contain water molecules and organic molecules that could be precursors of life forms.

Kohoutek is now travelling in an orbit that will return it to the inner Solar System in about 75,000 years.

However, there are some comets, called short-period comets, which come around the Sun on schedule every few years. These are the ones we plan to explore.

For example, in 1979 a spacecraft weighing about 4,500 pounds could be sent to make a slow fly-by of the Comet Encke, coming within 3,000 miles of the comet's nucleus.

Comet Encke comes back around the Sun every 3 years, so that we can make a series of close-up investigations of increasing difficulty.

After the fly-by mission, a rendezvous mission will be considered. It would permit the spacecraft to enter the inner coma of Comet Encke and travel along with it. (The coma, of course, is the nebulous mass which surrounds the nucleus of the comet.) After the spacecraft has made a close-up study of the nucleus, a landing on the nucleus might be attempted.

The missions to Comet Encke are doubly important. They will yield valuable information, and they will help us prepare for the opportunity to make a fly-by close to the best known comet of them all, Halley's Comet, in 1985.

Halley's Comet comes back around the Sun about every 75 years. Each of its appearances has been recorded since the year 240 B.C. When it returns in 1985 we will have our first opportunity to examine it with a full complement of modern instruments on the ground and in space.

It is proposed to fly the Halley spacecraft within about 5,000 miles of the comet's nucleus.

Tentative Plans to Visit Asteroids

Asteroids may be just as important to visit as planets and comets. Scientists believe asteroids can tell us a great deal about how the Solar System was formed and how life began here.

According to the "Payload Model" we could send two automated spacecraft to visit large asteroids in 1986. They could send back TV pictures and other data from very close range—from distances measured in feet rather than miles.

I assume that some day we will want to send scientists to land on asteroids. Such landings would be relatively easy to make because the gravity forces to be overcome on landing and take-off would not be great. But such landings are not in our tentative schedule for the next two decades.

Planetary exploration takes patience. It cannot all be done in one big push like the Apollo program. We have to move step by step, decade by decade, in many different directions. But even so, a great deal will be learned, and many exciting voyages made, by the time we are ready for manned missions to the planets.

Now let us look at payloads in Earth orbit in the 1980s and 1990s.

Payloads in Earth Orbit

Earth orbit: that is where most of the action will be in the Shuttle era, not out in the Solar System.

Of the 810 payloads in our "planning model," only 57 are destined for the Moon or planets and 753 for Earth orbit.

That's a ratio of 14 to 1 in favor of Earth orbit.

Put another way, in the 12 years beginning with 1980, we will average three payloads per year to the Moon and planets and 57 to Earth orbit.

That's a ratio of 19 to 1 in favor of Earth orbit during the Shuttle era.

Many of our spacecraft in Earth orbit during the Shuttle era will be much more advanced and much more productive operational versions of the experimental scientific and applications spacecraft we are flying in this decade.

On the science side, there will be the Large Space Telescopes, High Energy Astronomical Observatories, Large Solar Observatories, Large Radio Astronomy Observatories, and very sophisticated focusing X-Ray Telescopes.

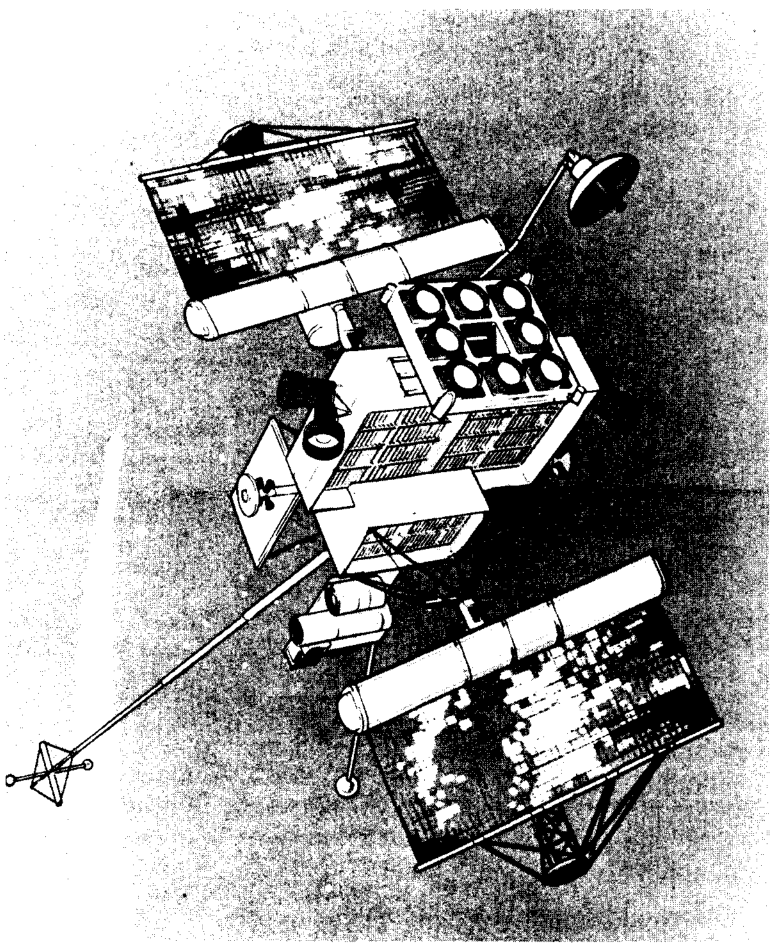
These large spacecraft, weighing up to 12 tons or more, will be unmanned but will be visited regularly by Space Shuttle crews and brought back to Earth for refurbishing from time to time. With these prospects for long term use, we can build excellent spacecraft for a modest investment.

With these observatories in action, we will make unprecedented gains in understanding the Universe and its energy sources in the 1980s and 1990s.

In the applications field we are considering large Earth Observatory Satellites weighing 3½ tons which will be in the Sun synchronous polar orbit now used by ERTS-1. These Observatories will use advanced remote sensing techniques to monitor environmental quality, observe the weather and the oceans, survey Earth resources, and facilitate land use planning.

In other words, we think of the Earth Observatory Satellites as a modular spacecraft—or bus—that could carry different groups of instruments to cover a wide variety of Earth observations for many different users.

The advanced remote sensing techniques for the large Earth Observatories have been, and are being, tested out on Skylab, ERTS-1, and other current programs.



A slow fly-by of the Comet Encke in 1979 is being considered as the first mission for the proposed Solar Electric Propulsion Stage (SEPS). The missions to Comet Encke will not only provide valuable information, it will help to prepare for a fly-by close to Halley's Comet in 1985.

We are tentatively planning to begin launching these large operational Earth observatories in 1978. Goddard Space Flight Center has asked for proposals to study its design. Two or more companies will be selected to conduct the studies.

We also plan to have operational Earth Observatories at synchronous orbit, beginning in 1981. The forerunners of these spacecraft are the two Synchronous Meteorological Satellites we plan to orbit this year. One significant difference is that the spacecraft we will orbit this year weigh 550 pounds but those planned for the Shuttle era weigh 5,000.

Another figure that indicates the direction we are heading concerns communications and navigation satellites.

NASA has only two planned at present: the Applications Technology Satellite (ATS-F) which will be launched this year and the Cooperative Applications Satellite which we are working on with Canada and which will be launched next year.

The "Payload Model," however, lists 120 communications or navigation satellites to be orbited by NASA for other agencies or private industry (not including the Department of Defense) through 1991. Forty-three of these are for commercial communications within the United States. I would guess this number will climb, but that is the present projection, and it is impressive, especially when you remember these satellites must be sent to synchronous orbit.

The trend for other agencies and other governments to use space is already clear.

Of the 25 payloads scheduled for launch by NASA this year, only eight are NASA payloads; three result from international cooperative efforts in which NASA is a partner; and 14 are being launched for others on a reimbursable basis.

Seven of the reimbursable launches involve commercial communications satellites—three international, three domestic, and one maritime communications satellite.

I cite these figures to show that intensive use of space by others is beginning, and NASA welcomes this trend.

Of the three hundred or so sortie payloads—those flown in the manned Spacelab module—most will be NASA payloads.

They include substantial numbers in:

- Astronomy
- Physics
- Earth Observations
- Space Processing
- Earth and Ocean Physics
- Communication and Navigation
- Life Science
- Space Technology.

Of the non-NASA payloads, 10 are expected to be flown for private industry in the space processing field, beginning in 1985.

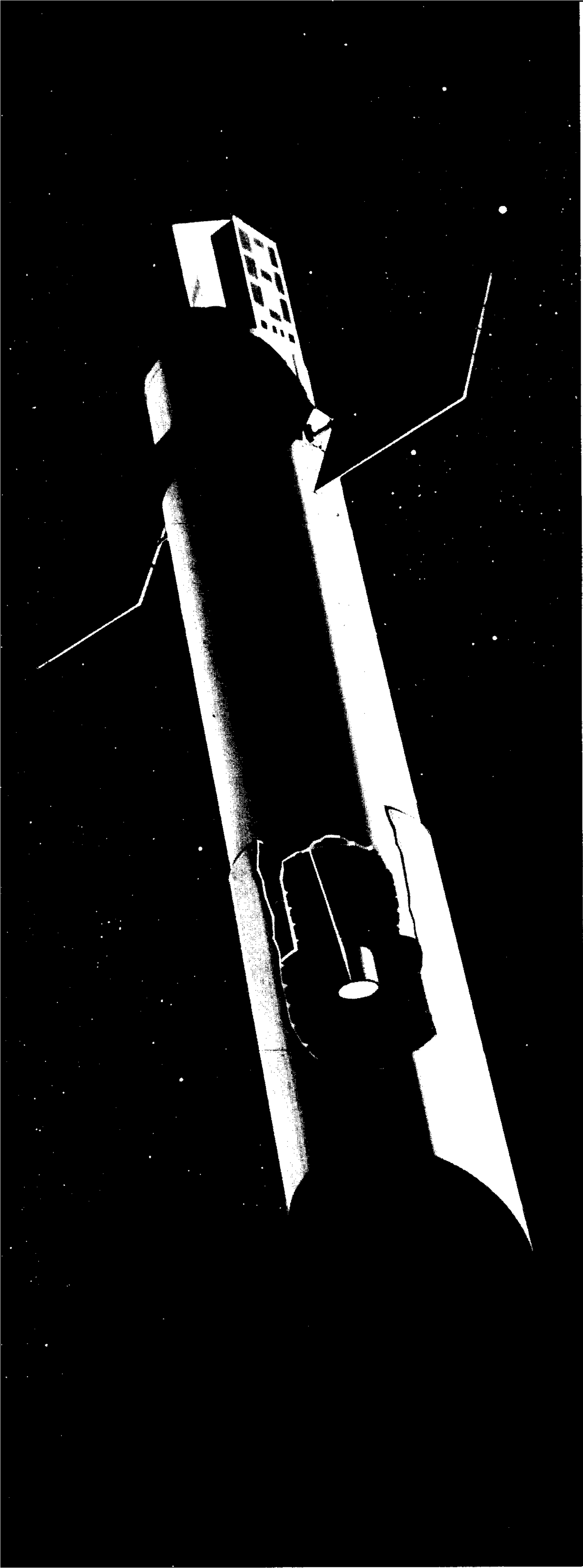
About 10 percent of the sortie payloads are expected to be foreign, but that's tentative, of course.

Shuttle Impact on Environment

One question naturally arises when we consider the large number of missions contemplated in our "Payload Model," coupled with a rapidly increasing number from the Soviet Union (which made three times as many launches as we did in 1973):

What will be the impact of all these launches on the global environment?

We have had this under careful study since the earliest consideration of the Shuttle and we expect it to have *very little* effect, and *no harmful* effect, on the environment.



Artist's conception shows a cutaway of the Large Space Telescope's secondary mirror. Scheduled to be launched and serviced by the Space Shuttle in the 1980s, LST is a multi-purpose optical telescope which will support a broad range of investigations at the forefront of astronomy.

The Sortie Lab is a simple pressurized laboratory module carried in the Space Shuttle cargo bay. It will allow space experimenters to participate directly in missions ranging from seven to thirty days.

The environmental impact statement that we filed two years ago discussed such things as Shuttle noise and sonic boom, and the influence of the rocket exhaust upon the atmosphere. We pointed out in that statement that the major constituents of the solid rocket booster exhaust will be water vapor, carbon dioxide, hydrogen chloride, and aluminum oxide, and we analyzed the anticipated effects on the troposphere and stratosphere, showing them to be negligible.

Since the filing of the environmental impact statement, our continuing studies have shown that the hydrogen chloride in the booster exhaust may give rise to free chlorine in the stratosphere, which laboratory experiments indicate might catalyze the destruction of some stratospheric ozone. There are, however, no data to show that this actually happens, and it is an extremely complicated question that we will continue to study. We fully expect that this will not turn out to be a problem, but should the effects turn out to be unacceptable, there are alternative propellants that we can use in the rocket booster, and we will do so.

Benefits of Shuttle Use

I have one final point I would like to make about the "1973 NASA Payload Model."

We have used it as the basis for a current study to compare the benefits offered by the Shuttle over present day or improved expendable launch vehicles.

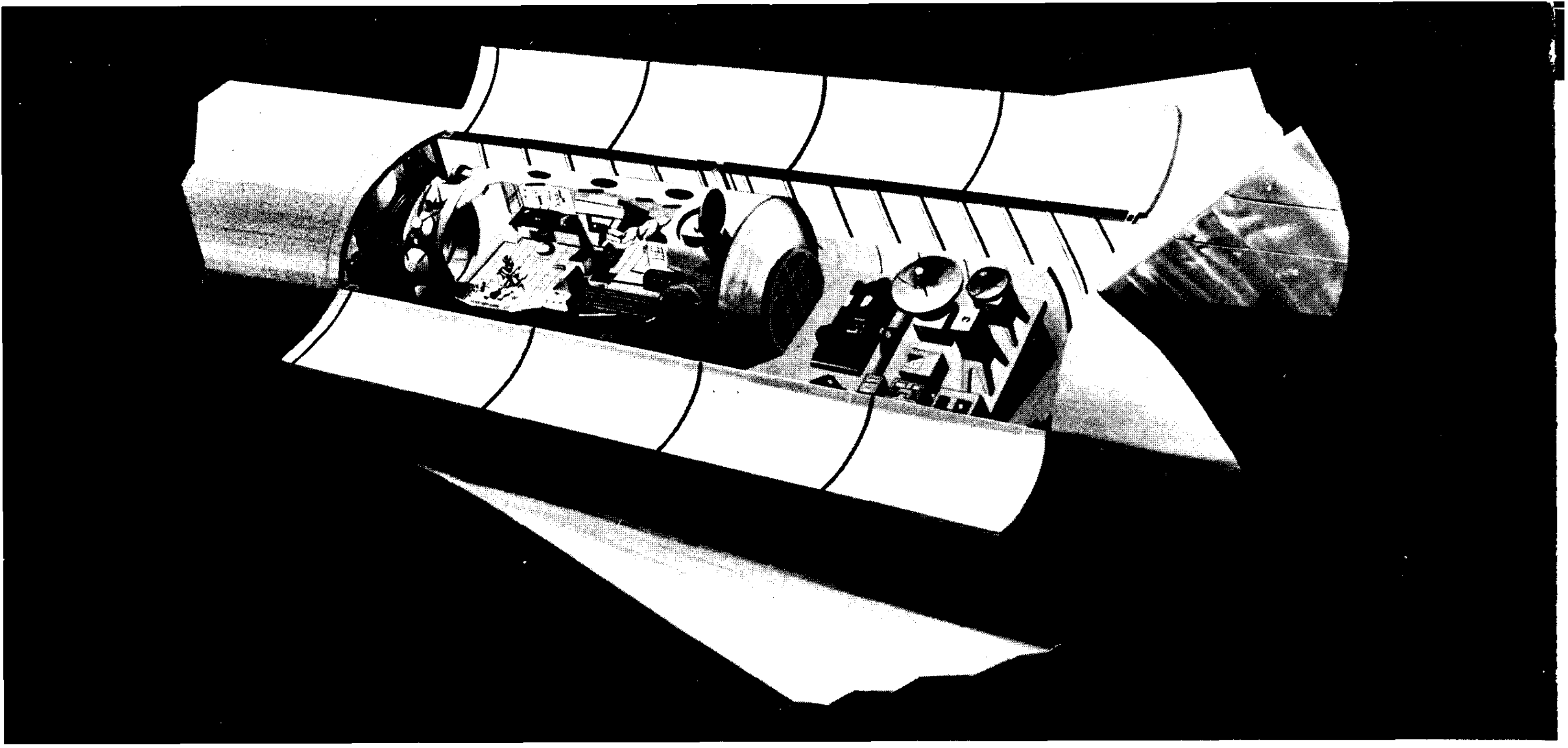
We have found that the benefits made possible by Shuttle use in the 12 years from 1980 through 1991 will average more than $1 billion per year.

Most of these benefits will result from the decreased cost of payloads and from their reuse, but the Shuttle also offers significant savings in transportation as well.

Questions

Now I would like to come back to the questions I usually get asked:

- When will Americans return to the Moon?
- When will we land men on Mars?
- When will we establish a Large Space Station in Earth orbit?



Man's Return to the Moon

It is quite possible that the Russians will send men to the Moon for short stays during this decade, as we have already done in the Apollo program.

Whether we will want to send men back to the Moon on short Apollo-type missions requires further study. It is probably better to wait until we are ready to begin establishment of manned scientific bases for long term use, like our present bases in the Antarctic.

As I see it now, such bases on the Moon are not likely, even after 1991, unless they are built in international projects with the cooperation of the Soviet Union, the United States, and perhaps even Europe. Such bases would be too expensive for one country alone.

Prospects for Manned Mars Landing

I think manned exploration of Mars will be undertaken after we have had experience with large Space Stations in Earth orbit and with long stays in scientific bases on the Moon. Not that these steps are required—rather they are logical next steps in an orderly progam.

Like scientific bases on the Moon, manned expeditions to Mars will likely be organized on an international basis. Even though such an undertaking is technically feasible now and would receive enthusiastic support from a large portion of the world's population, with all the other financial problems currently facing the developed countries it is unlikely that any one of them will foot the bill by itself—at least not in the next two decades.

Prospects for a Large Manned Space Station

Skylab has clearly shown the potential value of the Space Shuttle and the Spacelab module, which can serve as a small space station accommodating about four scientists for missions up to 30 days.

But Skylab has also convinced us that we will need Large Space Stations for long missions employing larger and more sophisticated instruments.

But NASA simply will not have the funds in this decade to develop both the Space Shuttle and a Large Space Station. Faced with that choice, we had to give priority to the Shuttle and the smaller Spacelab module.

It is very likely that the Soviet Union *will* develop a space station, and they may have it in orbit by the end of this decade. How it will compare in size and versatility and productivity with the manned Spacelab module the Europeans are developing for use with the Space Shuttle remains to be seen.

Conclusion

We should not be dismayed by the fact that cost factors require international cooperation on such large undertakings as scientific bases on the Moon and manned landings on Mars. We should welcome it.

I think such cooperation is an excellent way of helping to assure that we will enter the 21st century as a world at peace.

Will such long-term, large-scale international ventures in space be politically feasible one or two decades from now? I very much hope so. No one can say with certainty, of course. But I can point out that we have taken two important steps in this general direction already:

- The scheduling of the Apollo/Soyuz Test Project for 1975.
- The agreement with nine European countries to develop the manned Spacelab module for use with the Space Shuttle.

And by 1991 I anticipate that it will be clear to all that if it is desired to proceed on the major space missions of the future, there is no alternative to international cooperation—no alternative that is both feasible and appropriate in a world at peace.

It is, of course, difficult to plan now for the future beyond 1991. Our "Payload Model" goes about as far as one can go.

For the near future—for the next 18 years—we do have well planned space programs and possibilities which we can afford on a national basis, which do encourage international cooperation in space on a growing scale, and which are the logical next steps to explore and use space.

The many space achievements we have tentatively planned for the next 18 years will enrich our lives, advance our technology, and enhance our security. They will be achievements that we as a people can be very proud of.